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U.S. Department of Energy

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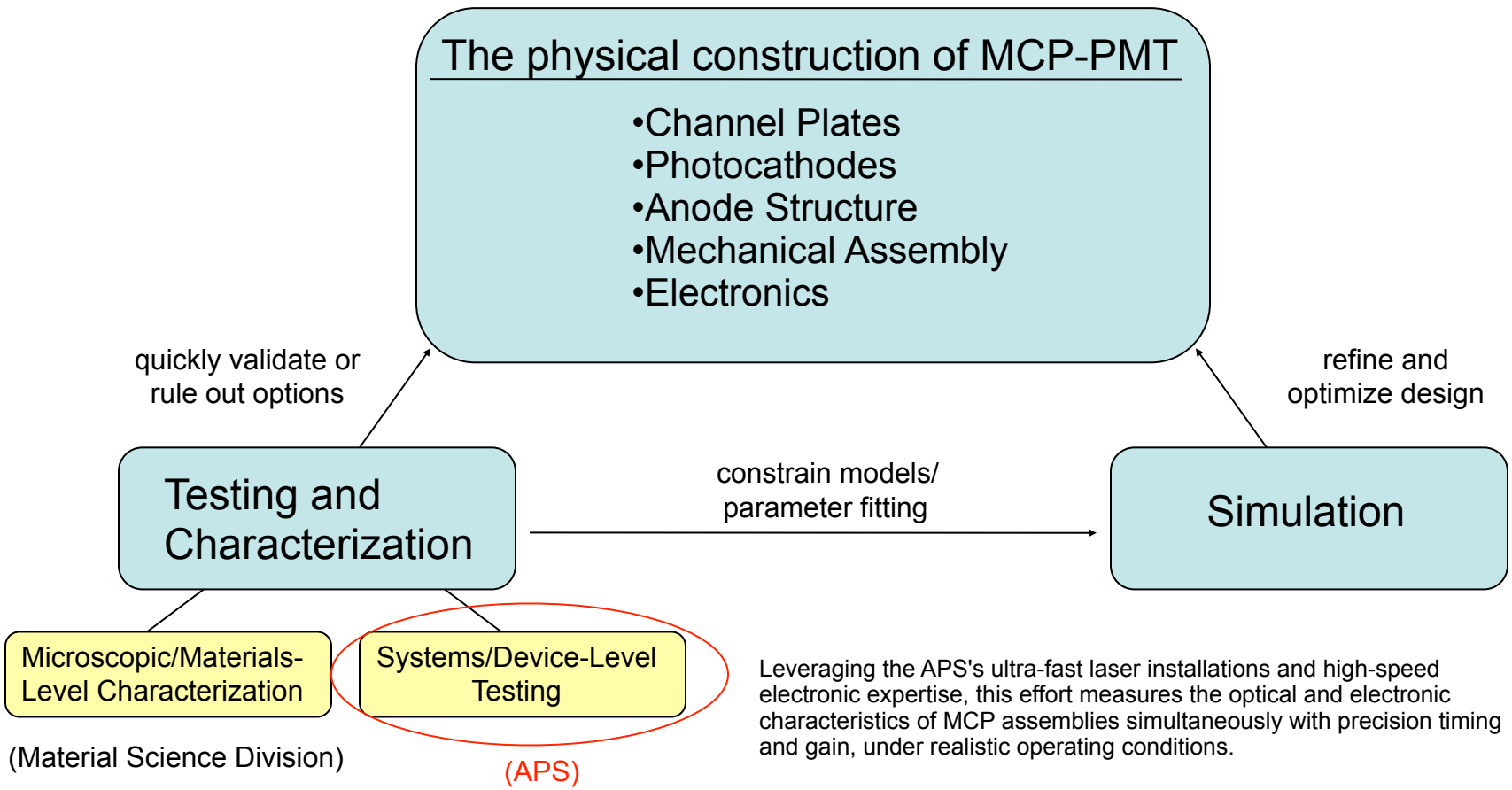
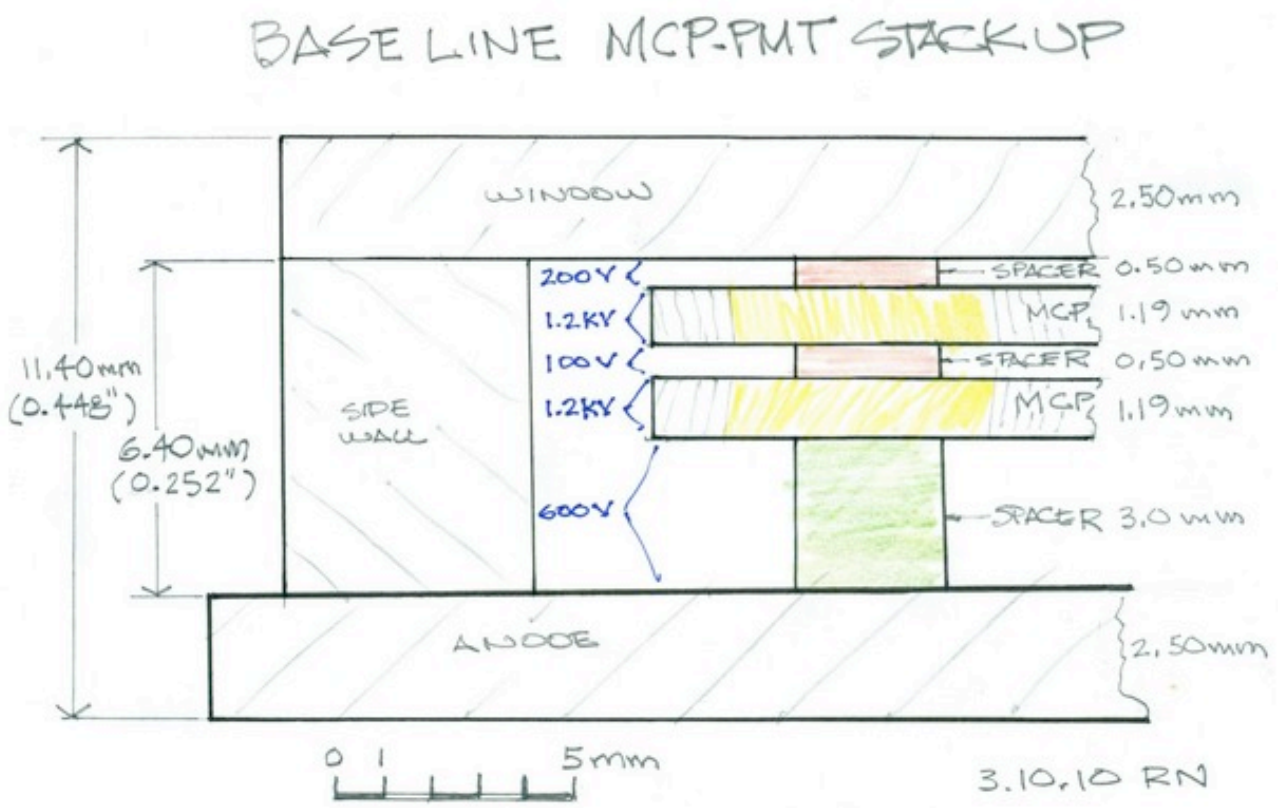
Review of MCP Testing at ANL



Leveraging the APS's ultra-fast laser installations and high-speed electronic expertise, this effort measures the optical and electronic characteristics of MCP assemblies simultaneously with precision timing and gain, under realistic operating conditions.

Characterization Program



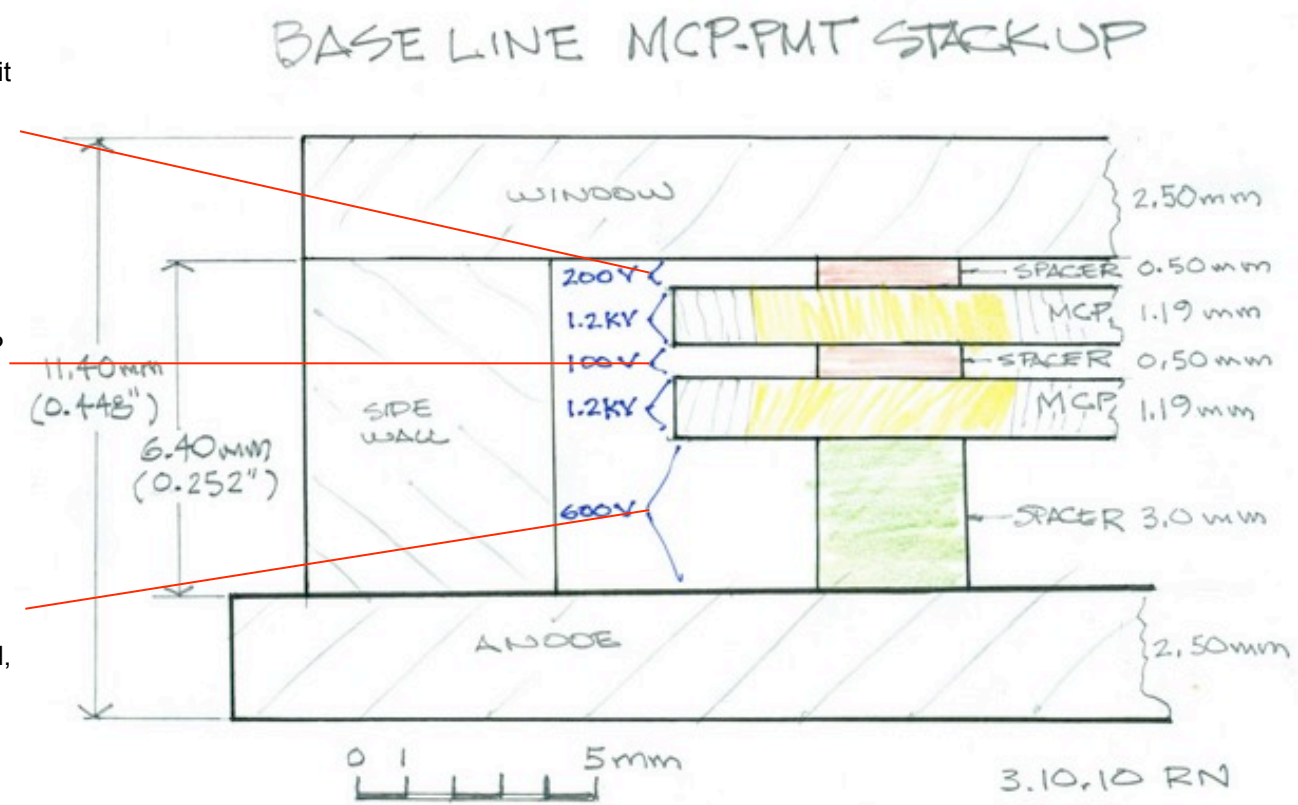
Characterization Program

Gap Spacing and Voltages

Gap 1: "First Strike":
Impacts on variability of transit time and amplification

Gap 2:
Impacts on saturation of MCP pair, spatial spread of signal.

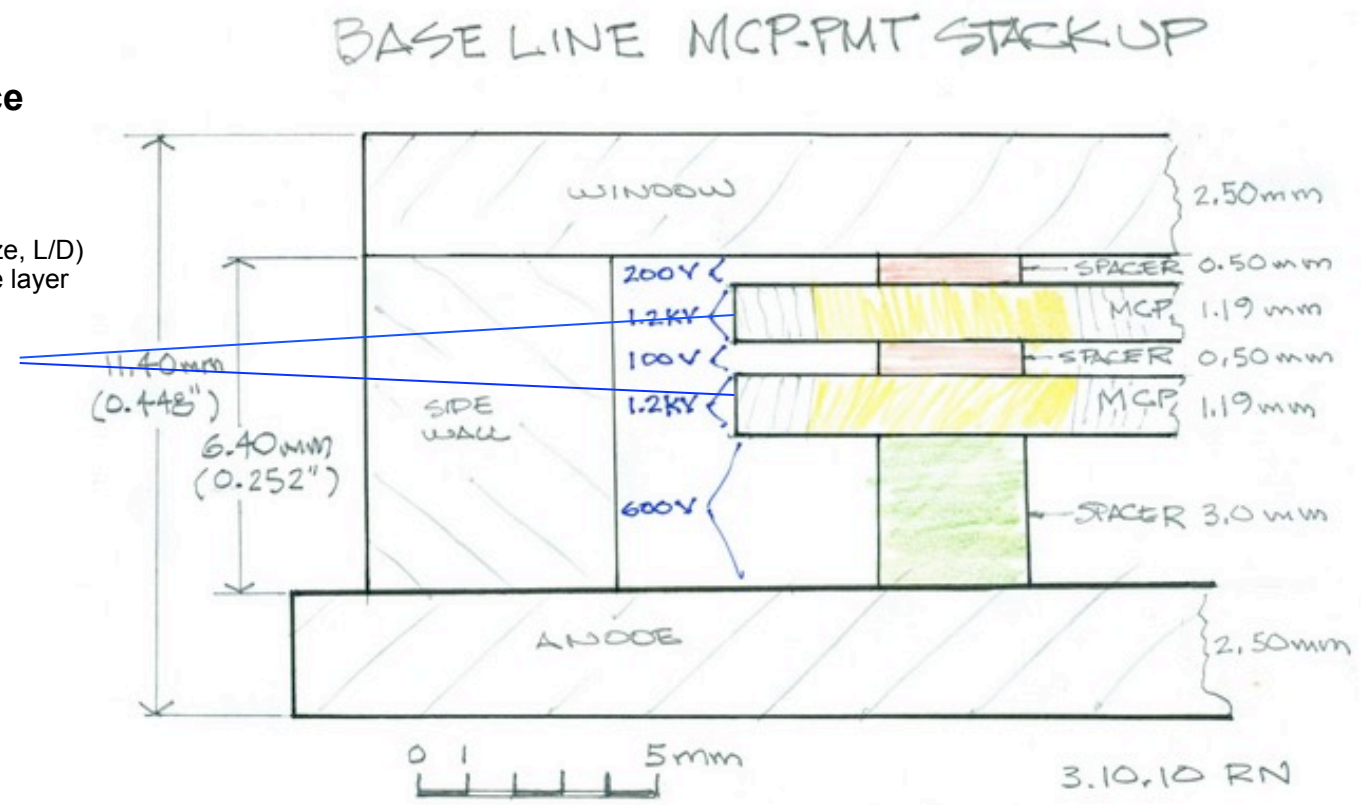
Gap 3:
spatial and temporal spreading of the charge cloud, space charge effects, interface with the anode



Characterization Program

MCP Performance

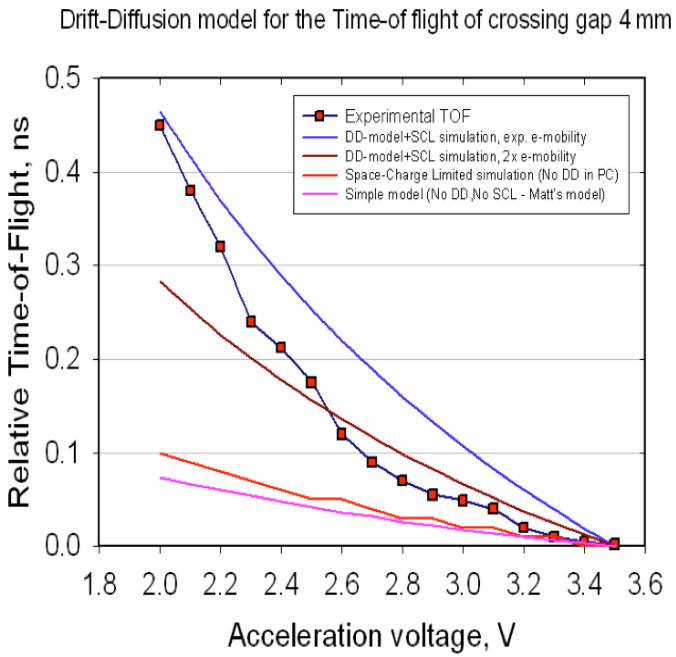
- Operational voltages
- Plate geometry (pore size, L/D)
- Materials: SEE, resistive layer
- Plate quality
  - uniformity
  - noise
  - stability
- Plate resistance
  - saturation
  - relaxation time

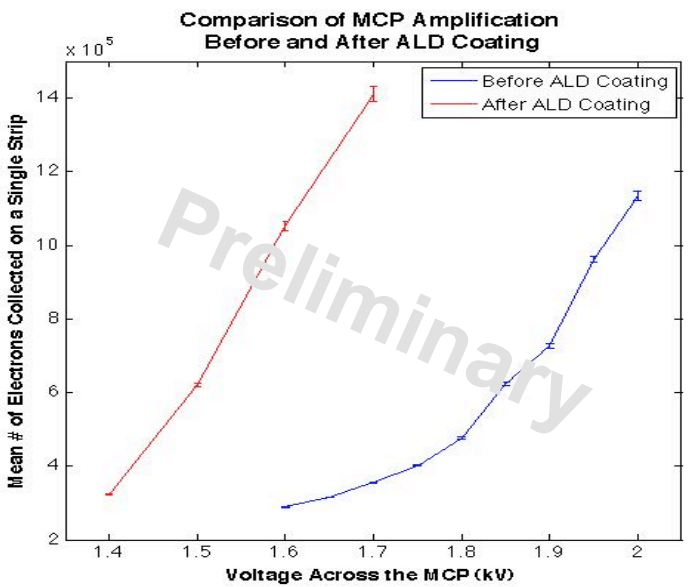


A Brief History of the Characterization Program

A-Flange → B'-Flange → B-Flange → Beyond

A quick first test setup. Look at some commercial MCPs. Perform preliminary timing measurements. Successful comparison of commercial MCPs, before & after ALD coating of SEE enhanced material.

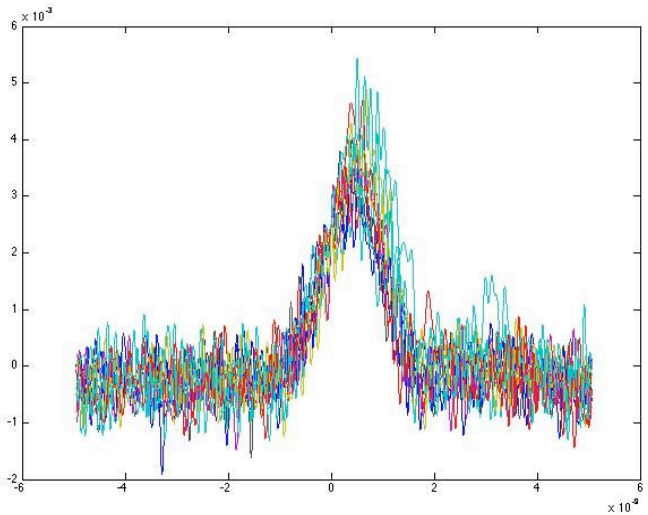


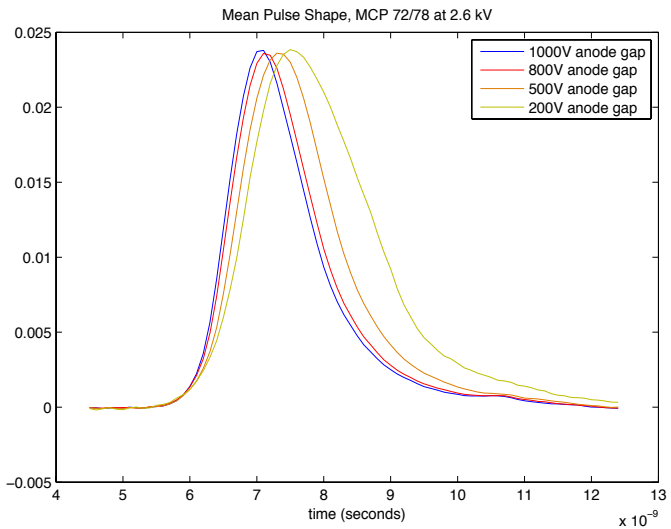


A Brief History of the Characterization Program

A-Flange → B'-Flange → B-Flange → Beyond

- A transitional setup, built closely to our final specifications.
- Iron out the technical problems in setup/methodology.
- Workout throughput/pipeline issuse.
- Perform first measurements of ALD-functionalized MCPs.

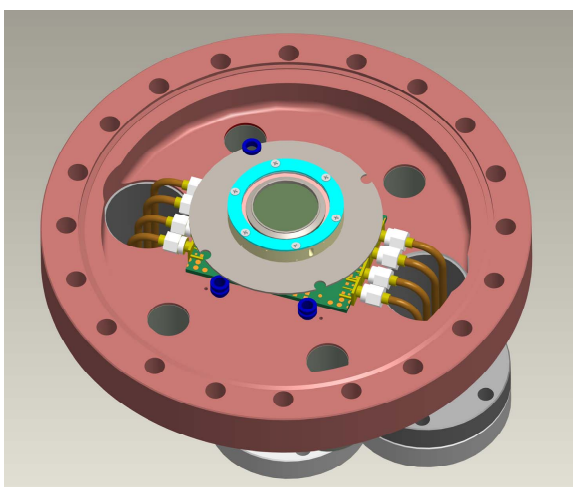


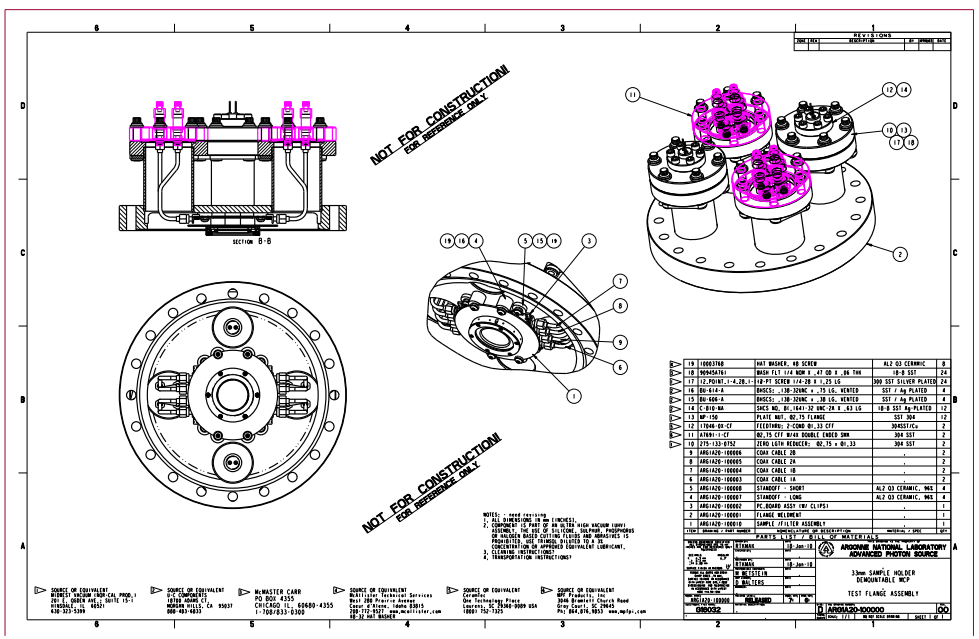


A Brief History of the Characterization Program

A-Flange → B'-Flange → **B-Flange** → Beyond

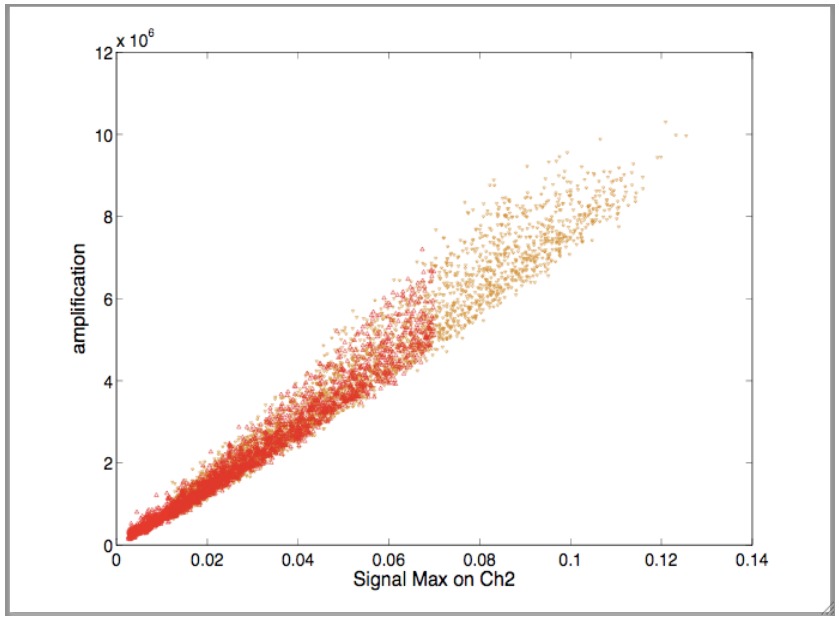
- Systematic and efficient characterization of ALD-MCPs.
- Characterization of systems-integration issues:
  - anode structure
  - data reconstruction techniques
  - electronics
- Move on to 8"x8", "Oreo cookies"

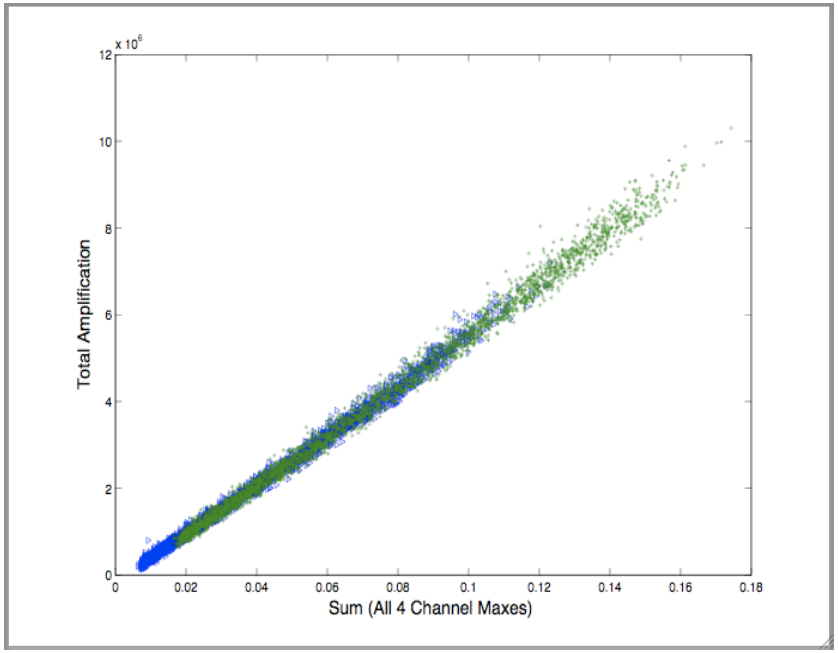




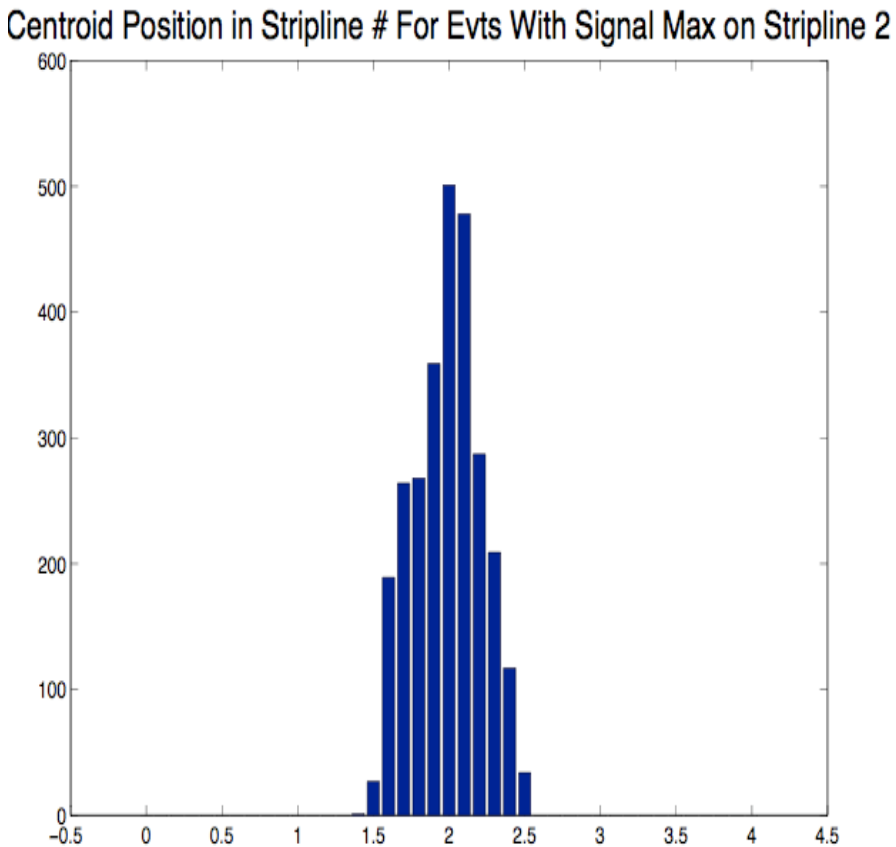
Summarizing the B' Results

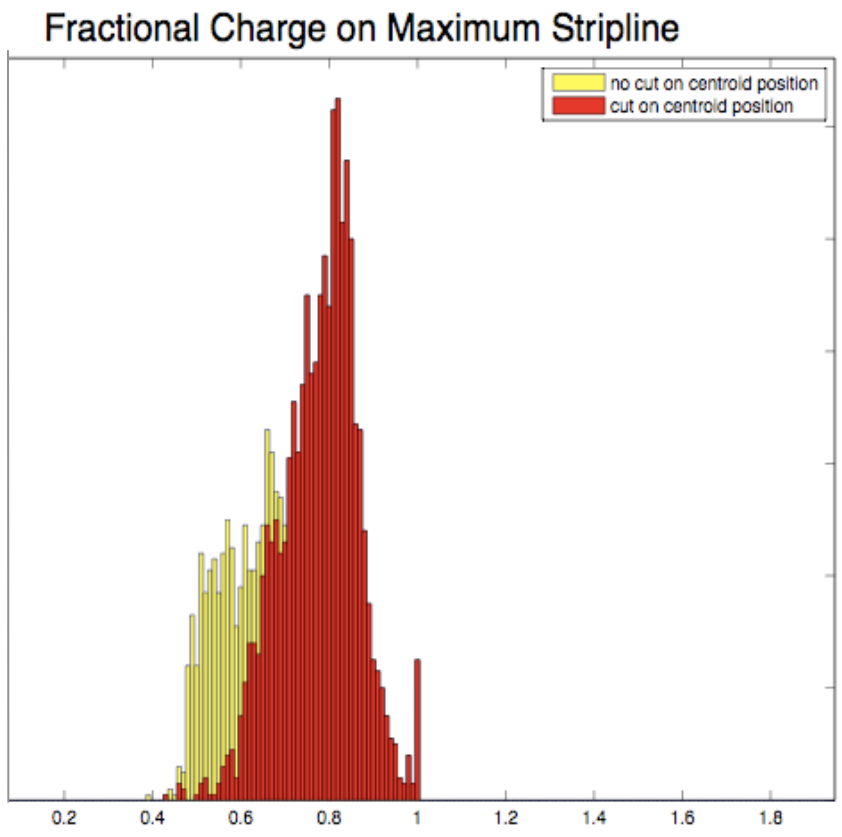
MCP 64/65: Splitting up the Scope Data



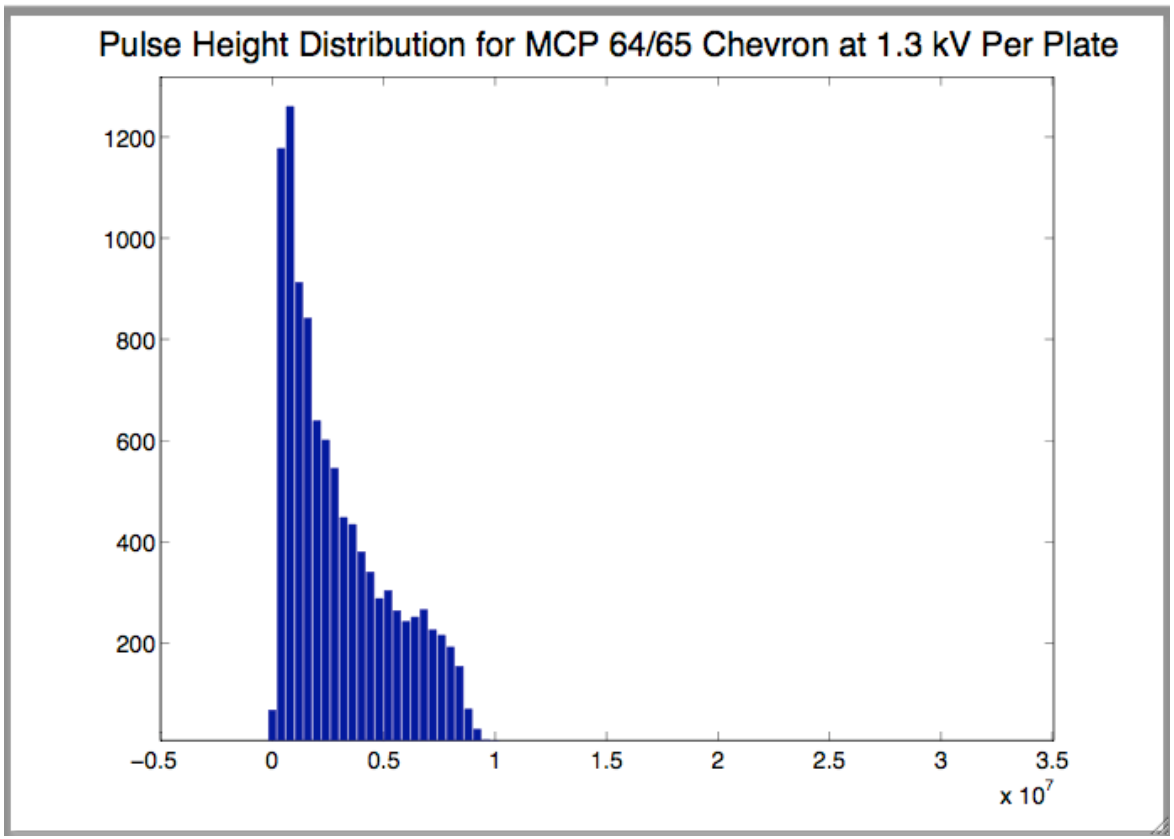


MCP 64/65


Centroid Position in Stripline # For Evts With Signal Max on Stripline 2
600
500
400
300
200
100
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5

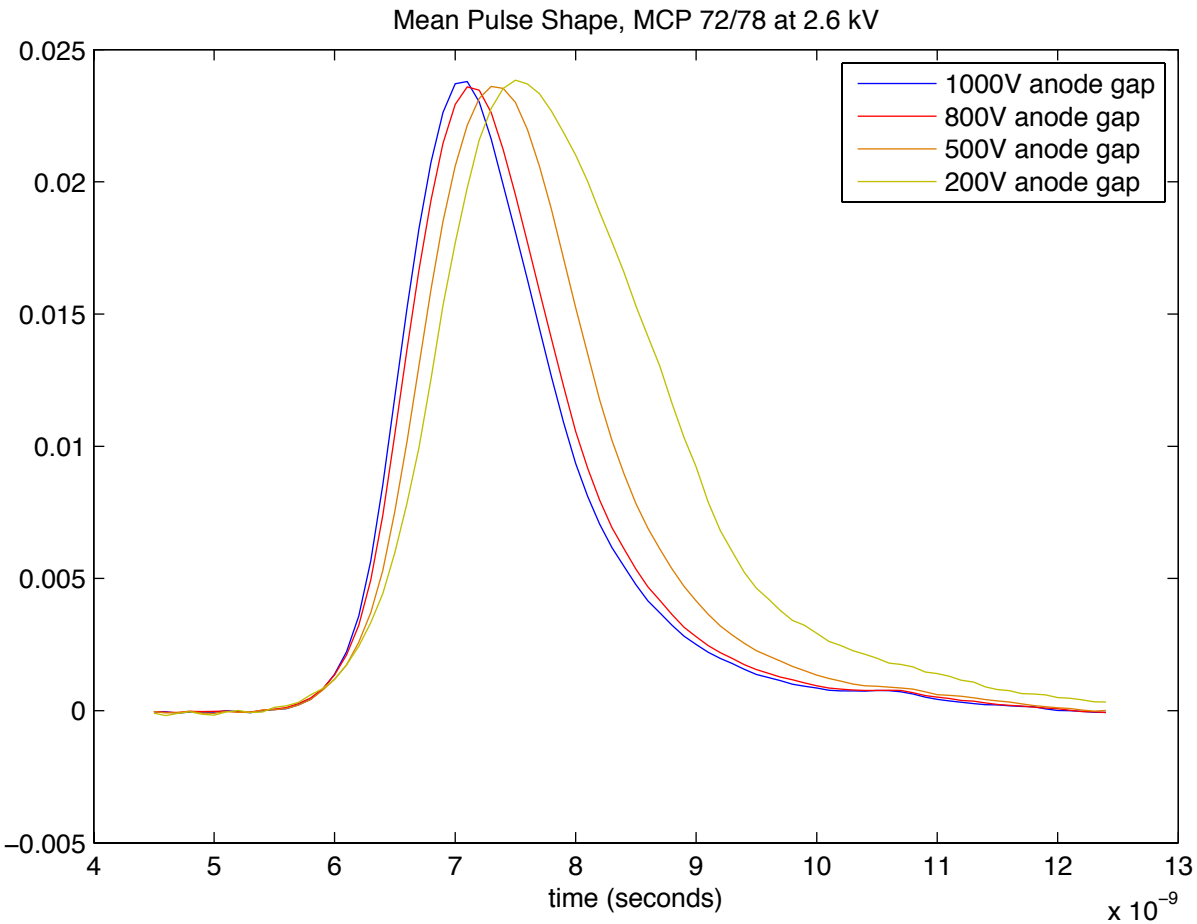

Fractional Charge on Maximum Stripline
no cut on centroid position
cut on centroid position
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8

MCP 64/65

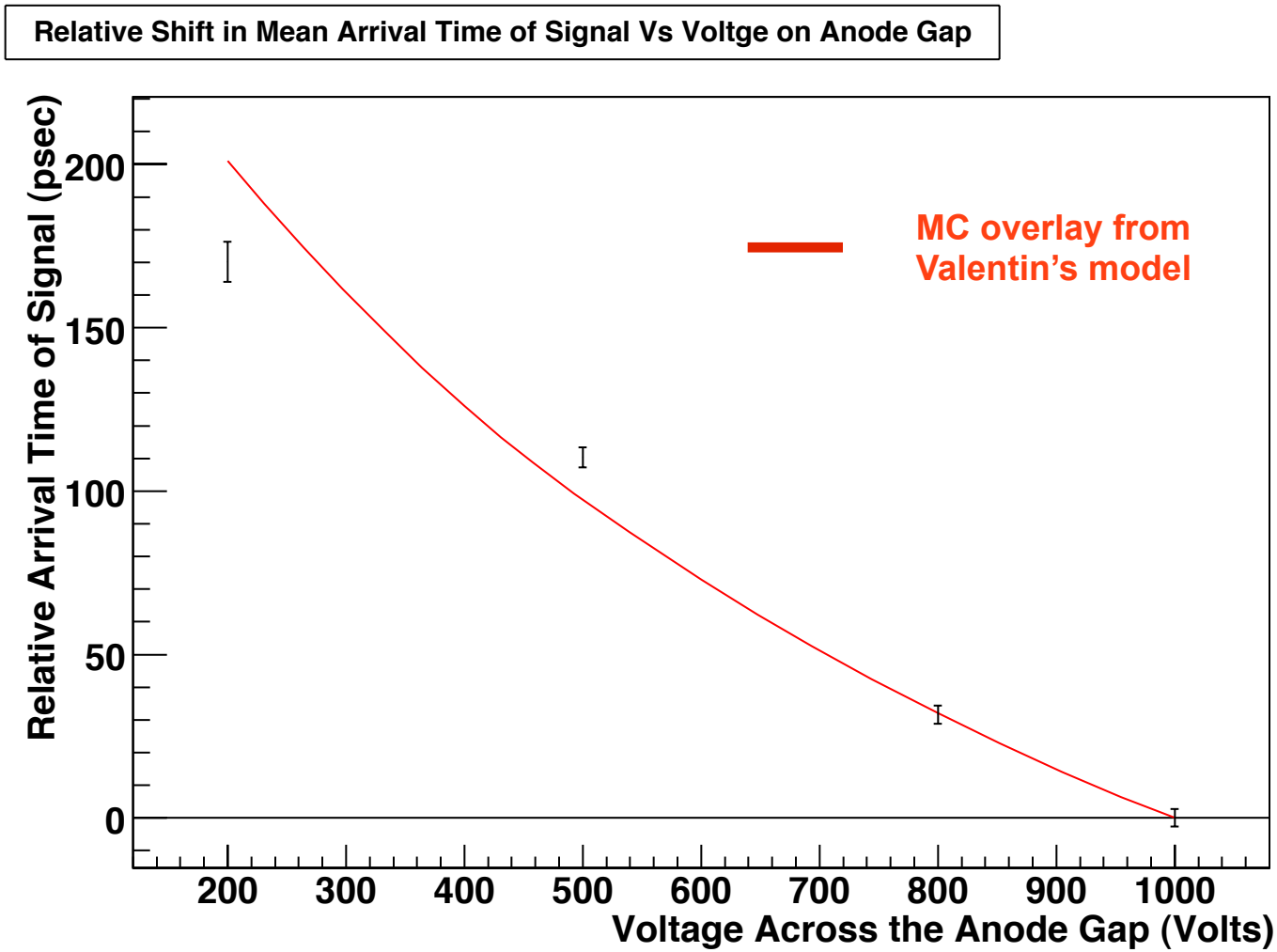


difficulties weaving together different data to form a cohesive pulse height distribution

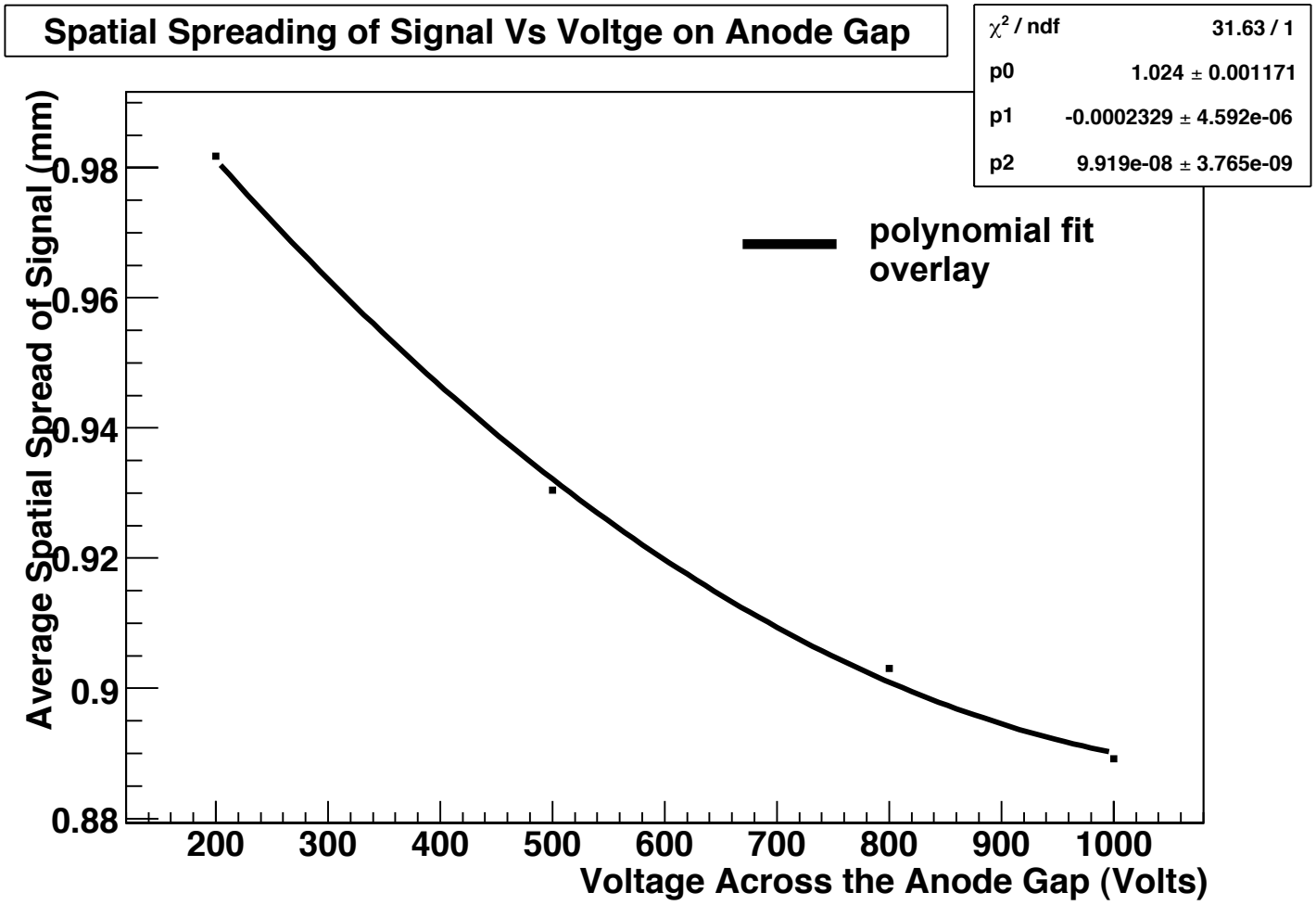
MCP 72/78


Mean Pulse Shape, MCP 72/78 at 2.6 kV
1000V anode gap
800V anode gap
500V anode gap
200V anode gap
0.025
0.02
0.015
0.01
0.005
0
−0.005
4
5
6
7
8
9
10
11
12
13
time (seconds)
x 10^−9

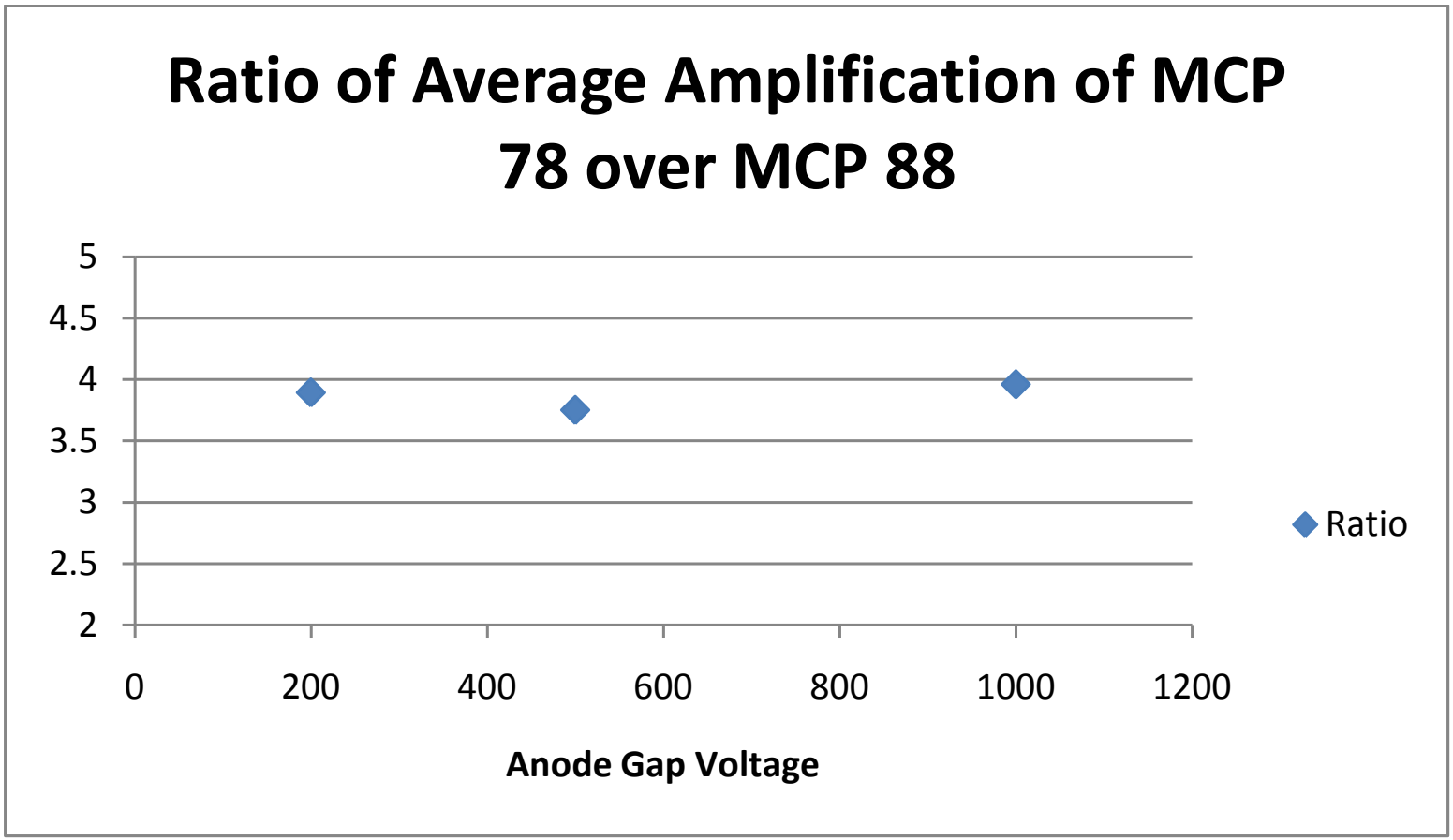
MCP 72/78


Relative Shift in Mean Arrival Time of Signal Vs Voltge on Anode Gap
Relative Arrival Time of Signal (psec)
200
150
100
50
0
MC overlay from
Valentin's model
200
300
400
500
600
700
800
900
1000
Voltage Across the Anode Gap (Volts)

MCP 72/78


Spatial Spreading of Signal Vs Voltge on Anode Gap
χ² / ndf 31.63 / 1
p0 1.024 ± 0.001171
p1 -0.0002329 ± 4.592e-06
p2 9.919e-08 ± 3.765e-09
polynomial fit overlay
Average Spatial Spread of Signal (mm)
0.98
0.96
0.94
0.92
0.9
0.88
200
300
400
500
600
700
800
900
1000
Voltage Across the Anode Gap (Volts)

MCP 72/78 Vs MCP 72/88:
20 vs 40 micron pores

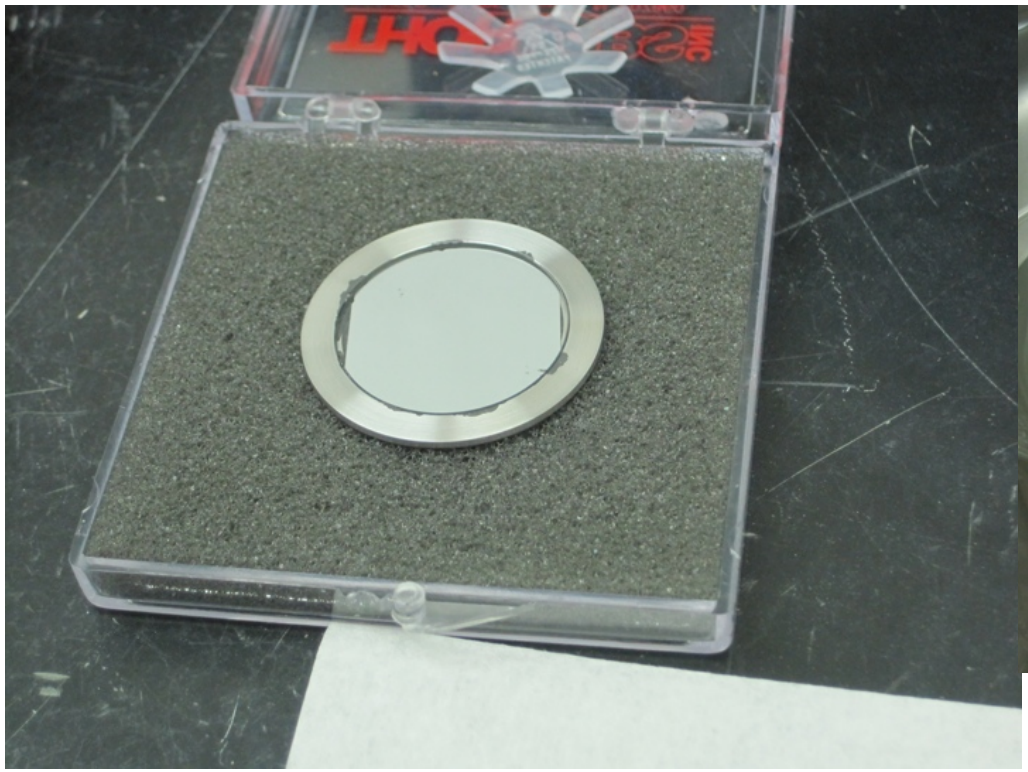


Where We're At With the B Setup

Clean(-er) Sample Preparation

MCP samples are now assembled in a flow bench with dry nitrogen spray gun...

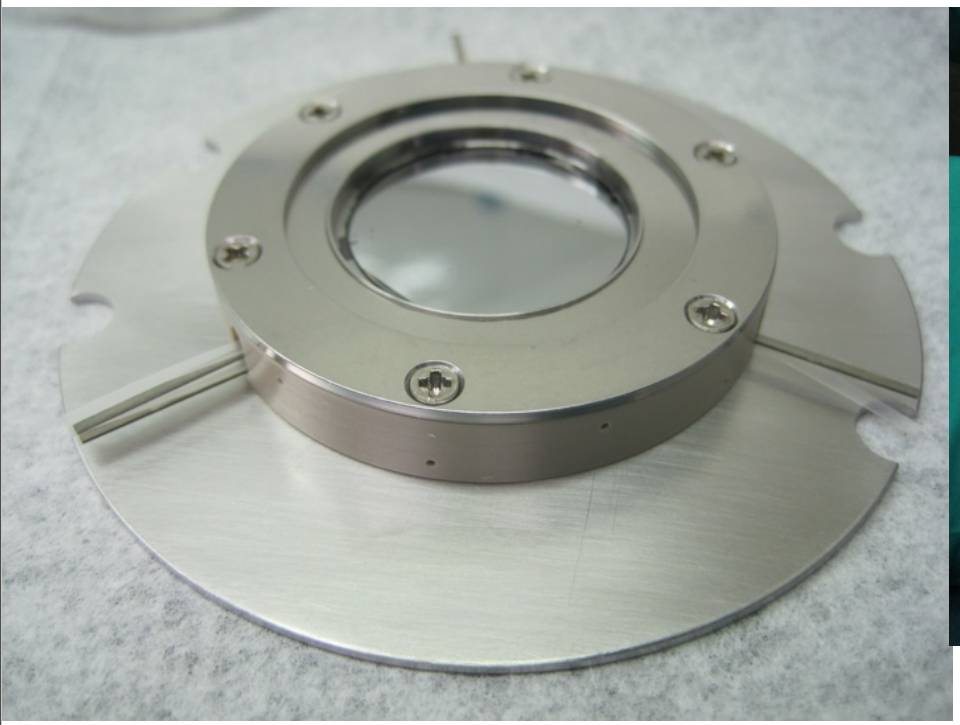
Clean(-er) Sample Preparation

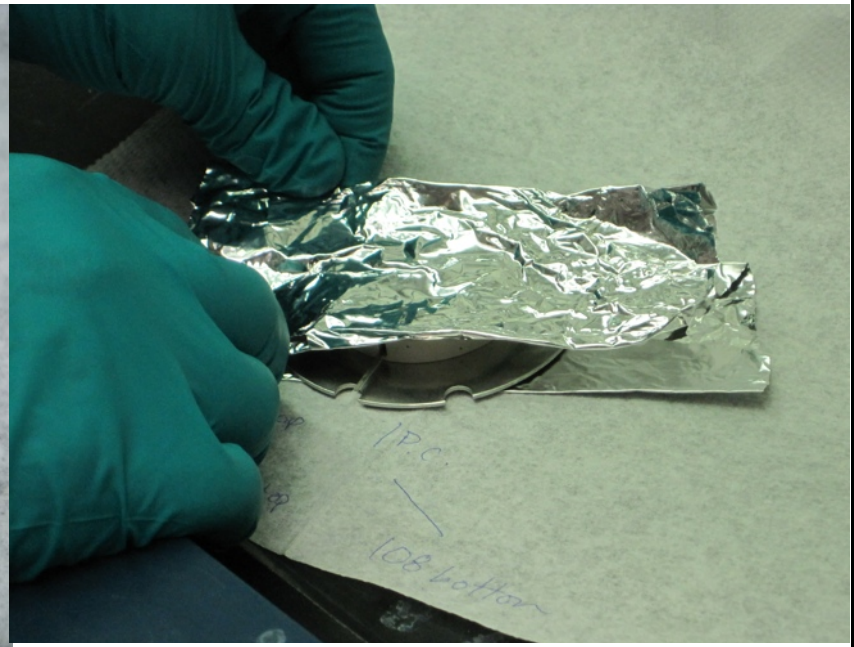


chrome photocathode on sapphire disk

MCP electrodes and pressure pads, cleaned sonically in an acetone bath

Clean(-er) Sample Preparation

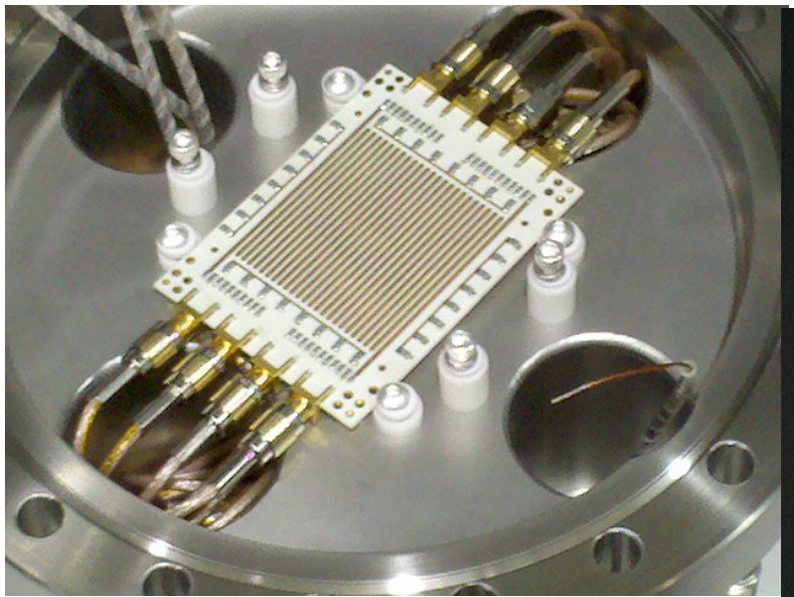




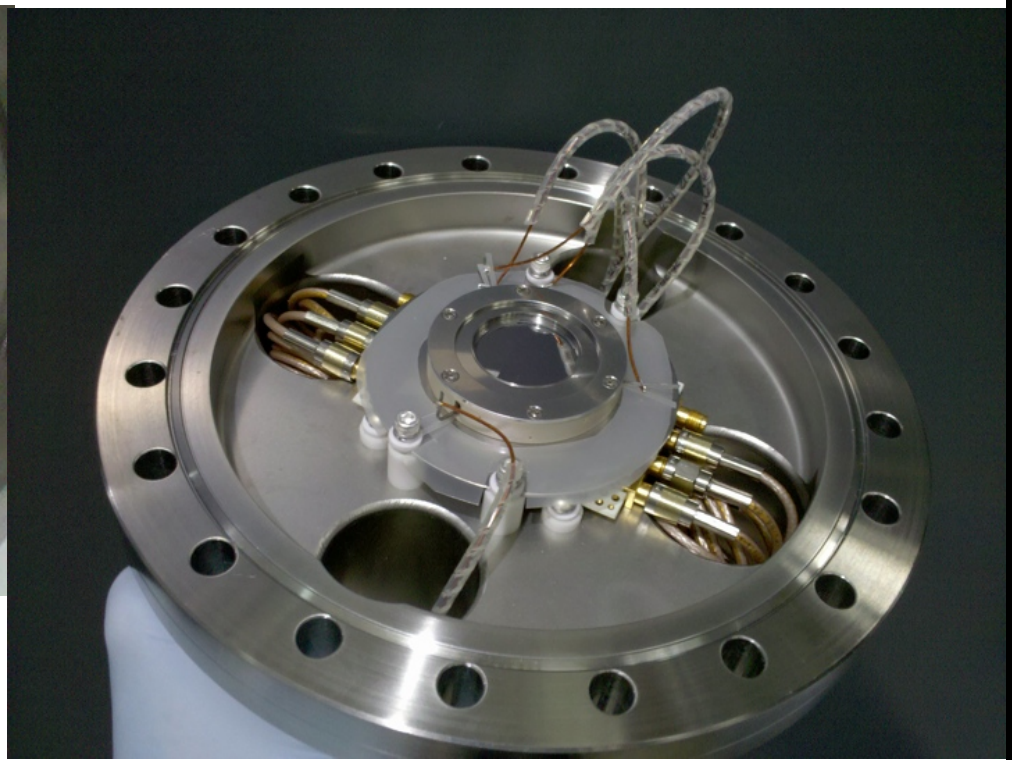
new sample holder with photocathode, inter-MCP spacing, and 5 HV connections

sample holder is covered with UHV-grade foil to protect from dust during transportation and mounting into the chamber

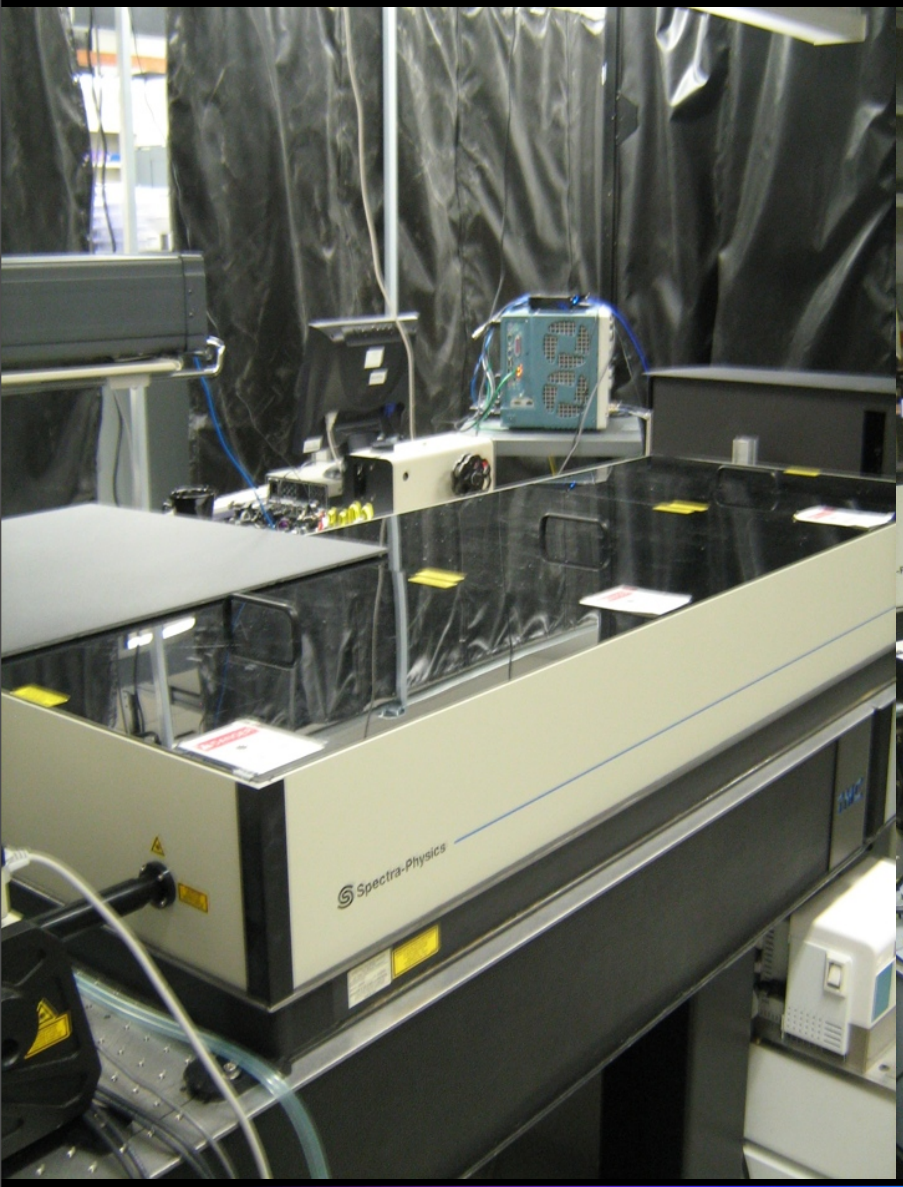
Putting it all together....

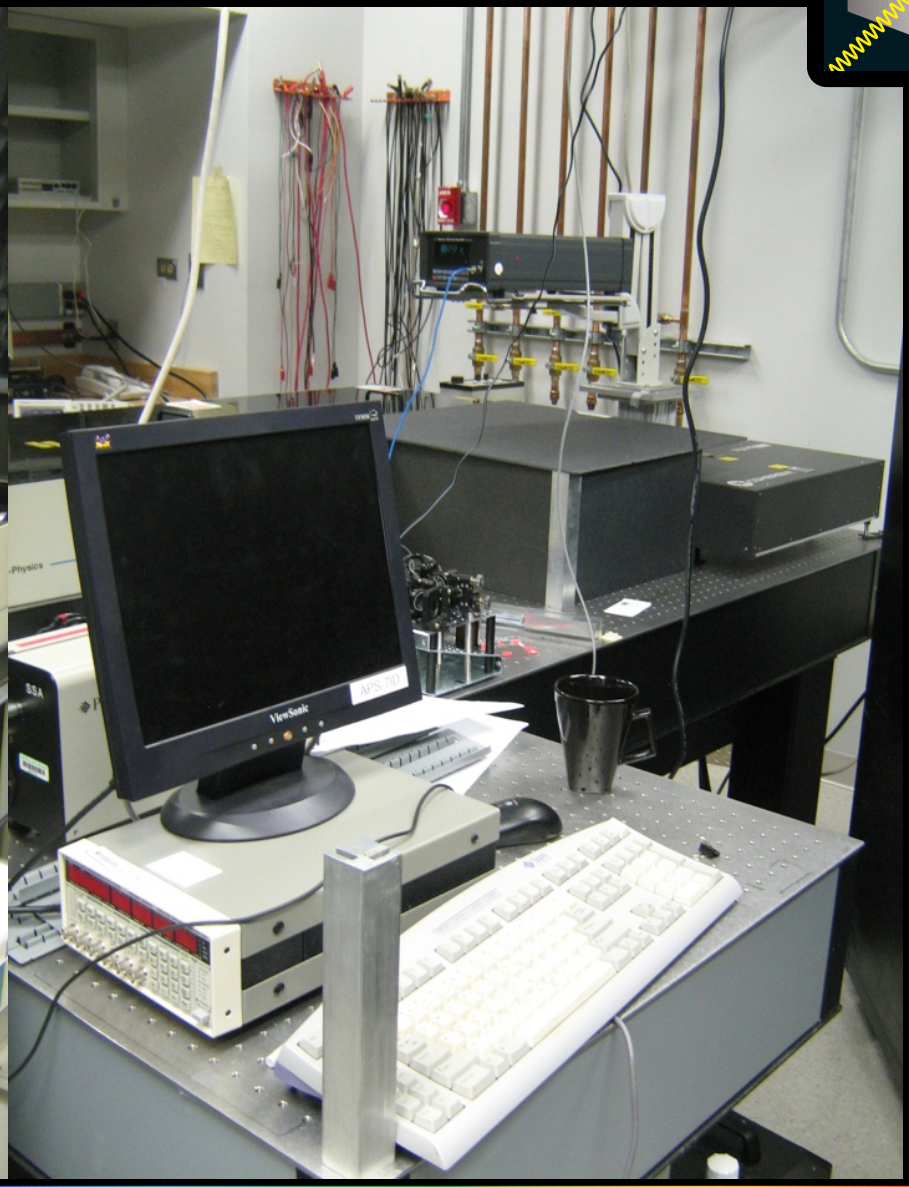


new signal board mounted on the B-flange



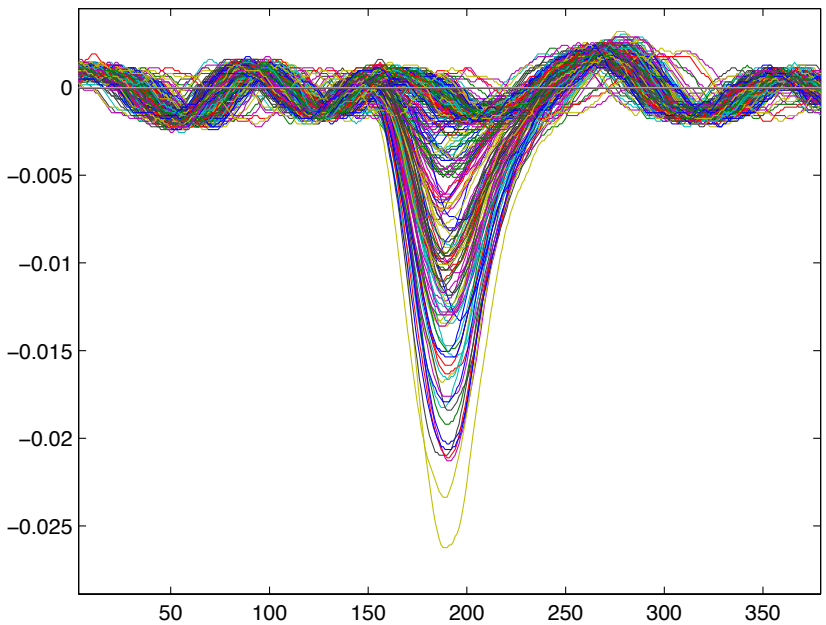
The fully assembled flange...

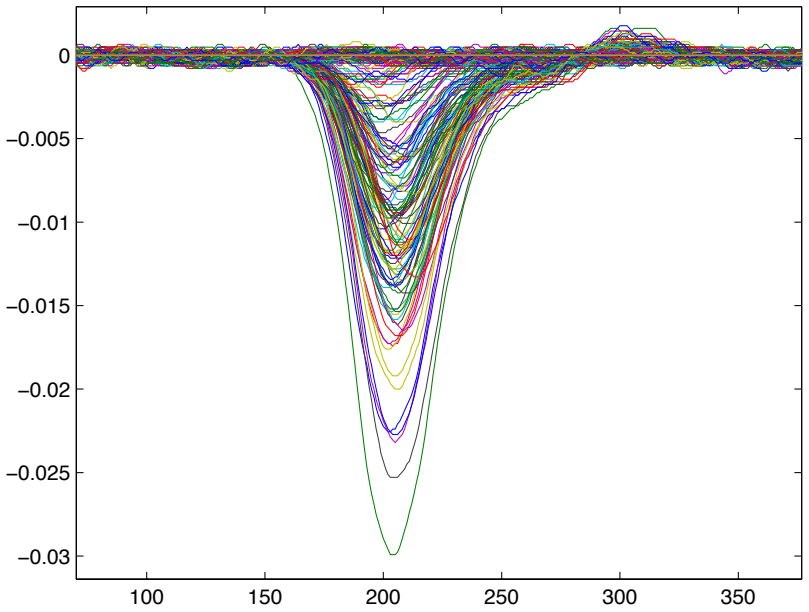

Spectra-Physics


ViewSonic

First Signal - New Lab/New Chamber

Noise from the laser (Polkel Cell Driver)!





Noise goes away with better cabling...

Status, in short...

- Already demonstrated 10^6 gains (project milestone).
- New facilities, dedicated laser, now available
- Automation-ready
- Working on improving handling/cleanliness
- Integrating lessons learned from the B'
- Summarizing B' results
- Ready to start taking measurements

Plans

Testing Challenges

- limited channels - up to 4, maybe 8 (with two scopes)
- limited dynamic range.
- inter-calibration of different scope settings
- electronics issues: DC offsets, pulse shaping
- noise!
- understanding anode effects - lost charge, noise
- controlling photon statistics - QE of photocathode
- precision measurement of optical/electronic delays

This requires a careful, systematic calibration program *in parallel* with testing program. Order maters....

Testing Challenges

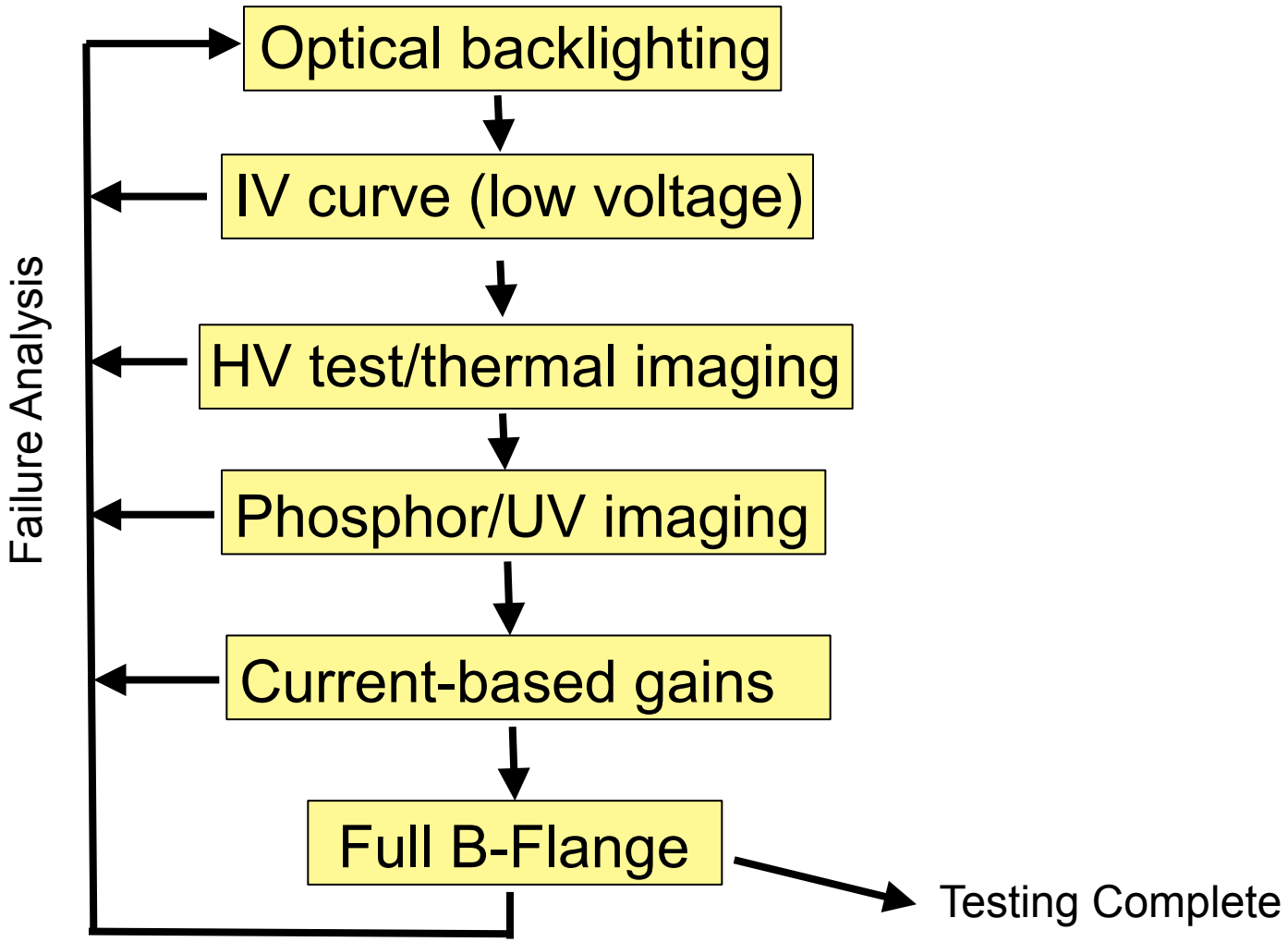
- limited channels - up to 4, maybe 8 (with two scopes)
  - should be enough for small spot-size
- limited dynamic range.
  - measurements at multiple scope scales
- inter-calibration of different scope settings
  - RF grade splitter, identical signal at different scope scales
- electronics issues: DC offsets, pulse shaping
  - baseline measurements, propagating known pulses through the elctronics
- noise!
  - appropriate cabling and shielding, long optical delay
- understanding anode effects - lost charge, noise
  - bare anode-cathode measurements for different structures
- controlling photon statistics - QE of photocathode
  - current versus intensity measurements with high light (for “average mode”)
  - photon counting with pair of known commercial plates (for “single PE mode”)
- precision measurement of optical/electronic delays
  - developing a quick, regular procedure. 3/4’s of the way there...

Testing Categories

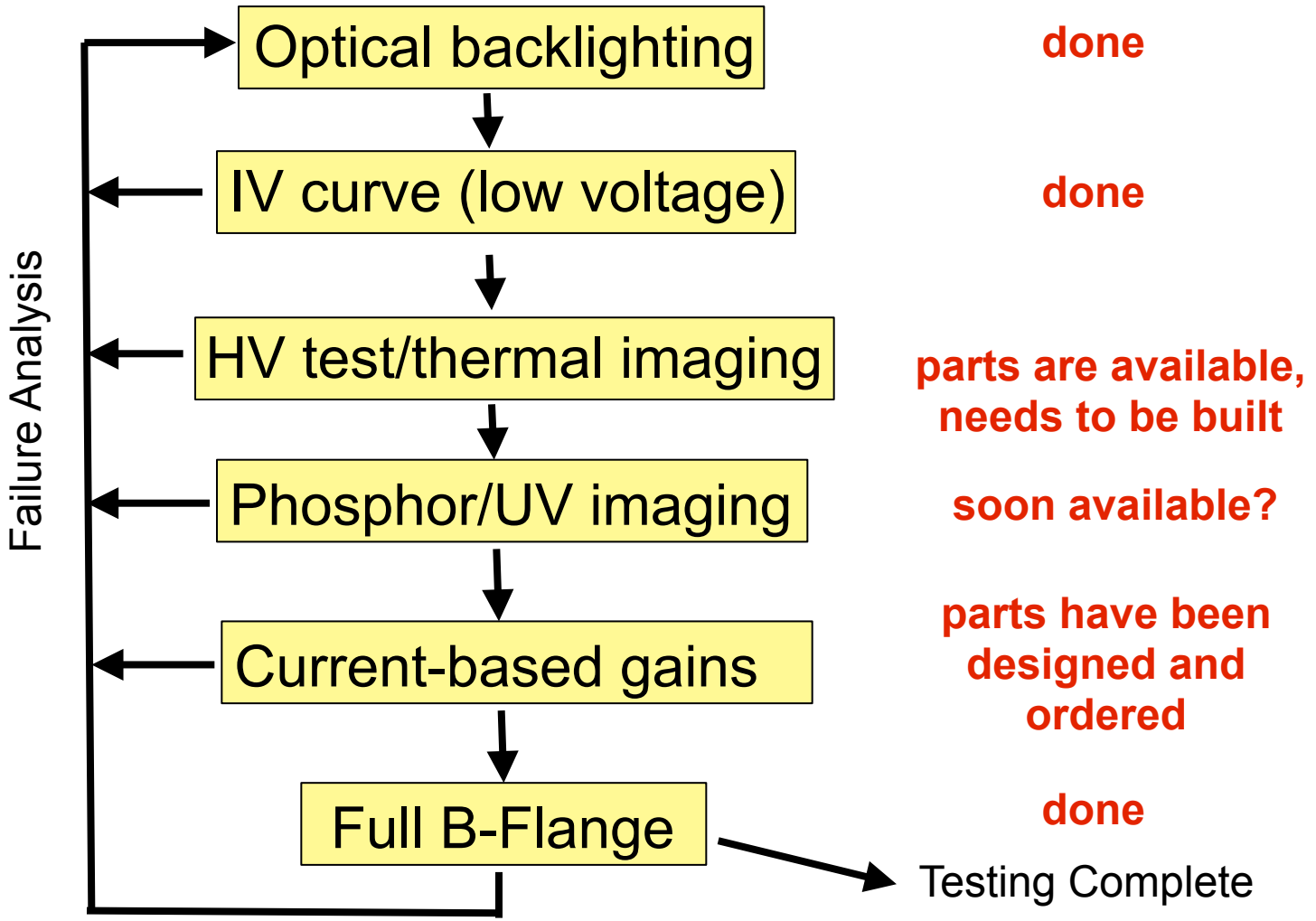
1. anode testing
   - single plate, PC board, glass, inside-out
2. single-plate testing in “average” mode
   - pulsed, many PEs per pulse, known input charge
3. “oreo cookie” testing
4. testing in single PE mode
   (a) single plate
   - gain and timing, pulse height distributions, different chemistries and voltages

   (b) two-plate
   - operational voltages, gain, timing, saturation, different chemistries/ combinations
5. 8” testing
6. sample consistency/long-term stability

Coordination with ALD Group

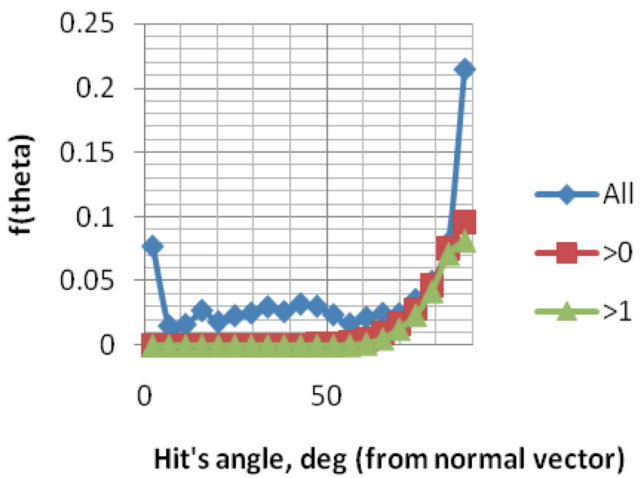


Coordination with ALD Group

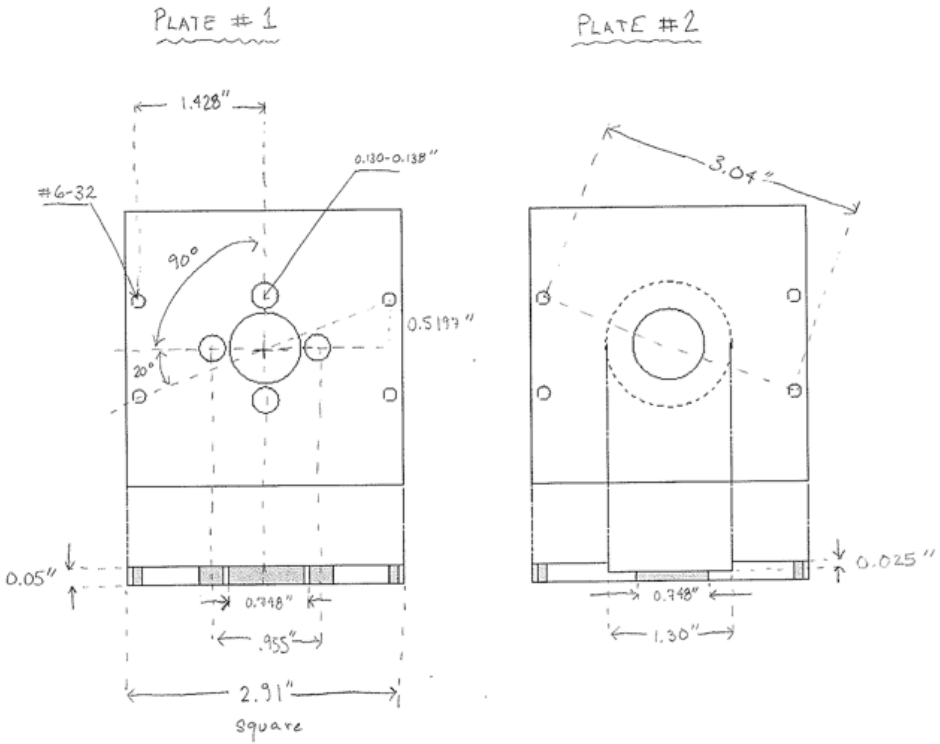


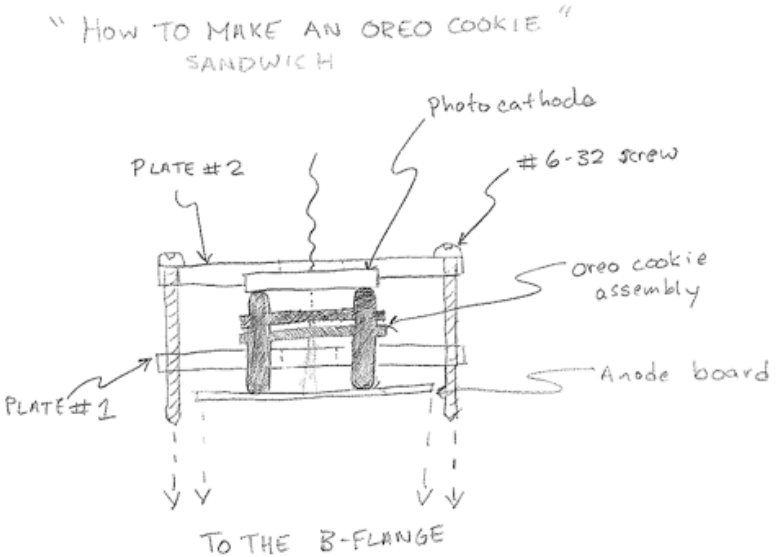
Coordination with Simulations

- Meeting/brainstorming session with Valentin in August
- Finishing up a note on the meeting
- Achievements
  - modularization of the code
  - now operational in a linux environment
  - goal to mass produce single-plate MC, using a simple batch system
- Conceptual questions
  - origin of statistical variability
  - back-scattering/elastic scattering
  - imperfect/varrying materials
  - operational parameters
- Benchmarks
  - single plate data-MC comparisons
  - MC-MC comparisons with Arradiance MC



"Oreo" Testing





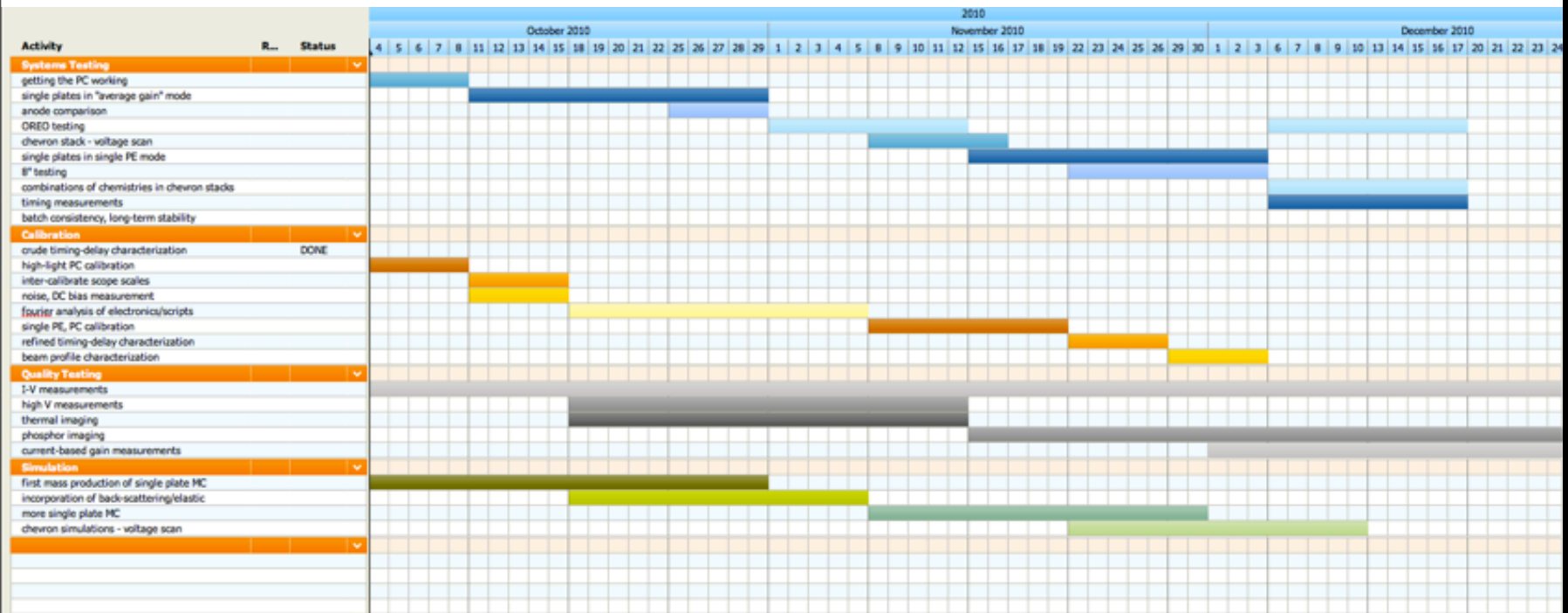
- mechanical assembly is being made now
- testable on B-flange
- should be ready, before the month's end

8” Testing

All the vacuum components of the 8” chamber are purchased and ready...

Working to design a simple, glass or alumina assembly to couple 8” plates to a stripline anode...Hope to be ready to test 8” plates by late November.

Putting it all together...



Making Plans

- Things are looking good
- Worried a bit about man-power
  - lots of measurements
  - acquisition and analysis are time consuming (shifts?)
- Also worried about swapping between chambers (8” testing), oreo cookies...
- Hoping to nail down a realistic schedule that balances all of our priorities (8”/oreo/single-plate/double plate/ chemistries/voltages)
- Hoping to start measuring single-plates in a week or so.